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INTERNATIONAL PRELIMINARY EXAMINATION REPORT

(PCT Article 36 and Rule 70)

Applicant's or agent's file reference FP2063	FOR FURTHER ACTION See Notification of Transmittal of International Preliminary Examination Report (Form PCT/IPEA/416)	
International application No. PCT/SG 2003/000245	International filing date (day/month/year) 13 October 2003 (13.10.2003)	Priority Date (day/month/year)
International Patent Classification (IPC) or national classification and IPC IPC⁷: H04N 1/60		
Applicant ZHANG, NENGSHENG, ALLAN		

1. This international preliminary examination report has been prepared by this International Preliminary Examination Authority and is transmitted to the applicant according to Article 36.

2. This REPORT consists of a total of 4 sheets, including this cover sheet.

☒ This report is also accompanied by ANNEXES, i.e., sheets of the description, claims and/or drawings which have been amended and are the basis for this report and/or sheets containing rectifications made before this Authority (see Rule 70.16 and Section 607 of the Administrative Instructions under the PCT).

These annexes consist of a total of 10 sheets.

3. This report contains indications relating to the following items:

- I. ☒ Basis of the opinion
- II. ☐ Priority
- III. ☐ Non-establishment of opinion with regard to novelty, inventive step and industrial applicability
- IV. ☐ Lack of unity of invention
- V. ☒ Reasoned statement under Rule 66.2(a)(ii) with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement
- VI. ☐ Certain documents cited
- VII. ☐ Certain defects in the international application
- VIII. ☐ Certain observations on the international application

Date of submission of the demand 07.04.2005	Date of completion of this report 11 November 2005 (11.11.2005)
Name and mailing address of the IPEA/AT Austrian Patent Office Dresdner Straße 87 A-1200 Vienna Facsimile No. 1/53424/200	Authorized officer FUSSY S. Telephone No. 1/53424/328

INTERNATIONAL PRELIMINARY EXAMINATION REPORT

International application No.

PCT/SG 2003/000245

I. Basis of the report

1. With regard to the elements of the international application:*

☐ the international application as originally filed

☒ the description:

pages 1-34, as originally filed

pages _____, filed with the demand

pages _____, filed with the letter of _____.

☒ the claims:

pages _____, as originally filed

pages _____, as amended (together with any statement) under Article 19

pages 35-44, filed with the demand

pages _____, filed with the letter of _____.

☒ the drawings:

pages 1-15, as originally filed

pages _____, filed with the demand

pages _____, filed with the letter of _____.

☐ the sequence listing part of the description:

pages _____, as originally filed

pages _____, filed with the demand

pages _____, filed with the letter of _____.

2. With regard to the language, all the elements marked above were available or furnished to this Authority in the language in which the international application was filed, unless otherwise indicated under this item.

These elements were available or furnished to this Authority in the following language _____ which is:

☐ the language of a translation furnished for the purposes of international search (under Rule 23.1(b)).

☐ the language of publication of the international application (under Rule 48.3(b)).

☐ the language of the translation furnished for the purposes of international preliminary examination (under Rule 55.2 and/or 55.3).

3. With regard to any nucleotide and/or amino acid sequence disclosed in the international application, the international preliminary examination was carried out on the basis of the sequence listing:

☐ contained in the international application in printed form.

☐ filed together with the international application in computer readable form.

☐ furnished subsequently to this Authority in written form.

☐ furnished subsequently to this Authority in computer readable form.

☐ The statement that the subsequently furnished written sequence listing does not go beyond the disclosure in the international application as filed has been furnished.

☐ The statement that the information recorded in computer readable form is identical to the written sequence listing has been furnished.

4. ☐ The amendments have resulted in the cancellation of:

☐ the description, pages _____.

☐ the claims, Nos. _____.

☐ the drawings, sheets/fig _____.

5. ☐ This report has been established as if (some of) the amendments had not been made, since they have been considered to go beyond the disclosure as filed, as indicated in the Supplemental Box (Rule 70.2(c)).**

* Replacement sheets which have been furnished to the receiving Office in response to an invitation under Article 14 are referred to in this report as „originally filed“ and are not annexed to this report since they do not contain amendments (Rules 70.16 and 70.17).

** Any replacement sheet containing such amendments must be referred to under item 1 and annexed to this report.

INTERNATIONAL PRELIMINARY EXAMINATION REPORT

International application No.
PCT/SG 2003/000245

V. Reasoned statement under Article 35(2) with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement

1. Statement			
Novelty (N)	Claims	1 -42	YES
	Claims	---	NO
Inventive step (IS)	Claims	1-42	YES
	Claims	---	NO
Industrial applicability (IA)	Claims	1-42	YES
	Claims	---	NO

Citations and explanations (Rule 70.7)

The following documents have been cited in the Search Report:

D1: EP673155A2

D2: US5218555A

D1 represents the prior art coming closest to the subject-matter of the amended independent claims 1, 16, 30, and 37 to 39 of the present application and relates to a data correction sub-system for a colour image processing system including a colour image reading device and a colour image printing device. A chart file is transmitted to the printing device so that the printing device produces a sample chart. Calibration data is calculated from the read sample so that the read sample data can be corrected to corresponding data in the chart file. The read sample data is obtained by causing the reading device to read the sample chart. Printing data to be transmitted to the printing device is corrected using the calibration data.

However, no method of calibrating a print engine comprising the step of arranging a separate calibration chart on a test sheet and digitising both sheets in one step is disclosed in D1.

D2 which is already mentioned in the present application discloses a colour analysis for a textile fabric involving the judgement if a colour difference exists within a predetermined range and judging whether colour difference is substantial or negligible according to fuzzy inference.

However, neither a method of calibrating a print engine comprising the step of printing a test sheet nor comprising the steps of arranging a separate calibration chart on said test sheet and digitising both sheets in one step, calculating a colour difference and adjusting the print engine according to said difference are disclosed in D2.

Supplemental Box

(To be used when the space in any of the preceding boxes is not sufficient)

Continuation of: Box V (page 1)

The remaining claims 2 to 15, 17 to 29, 31 to 36, and 40 to 42 of the present application specify preferred embodiments of the subject-matter of the independent claims 1, 16, 30, and 39.

Summarizing, all of the above cited documents merely define the state of the art. Therefore, the subject-matter of amended claims 1 to 42 can be considered novel and involving an inventive step.

Industrial applicability is given.

1. A method of calibrating a print engine based on a calibration chart having a first plurality of reference colours, the method comprising the steps of
- 5 i) printing a test sheet from the print engine; the test sheet having a second plurality of test colours thereon, each test colour corresponding to a reference colour;
- ii) digitising the reference and test colours;
- iii) calculating a colour difference between corresponding pairs of
- 10 digitised reference and test colours; and
- iv) adjusting the print engine in accordance with the difference to reduce the colour difference between each colour pair, wherein the calibration chart includes openings formed therein, the openings corresponding to the positions of the second plurality of test colours, and the method
- 15 further comprises the step of:
- arranging the calibration chart on the test sheet prior to step (ii).
2. A method according to claim 1, wherein each reference or test colour is formed from a combination of one or more colour components.
- 20
3. A method according to claim 1, wherein each reference or test colour is formed from a combination of two or more colour components.
4. A method according to claim 2 or 3, wherein step (ii) further comprises
- 25 the steps of:

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obtaining pixel information representing each digitised test and/or reference colour; and

computing each colour component's intensity at each pixel.

- 5 5. A method according to claim 4, further comprising the step of:
averaging the computed intensities to obtain a mean intensity of each
colour component for each test and reference colour; and
calculating the difference in mean intensity between corresponding pairs
of test and reference colours, the calculated difference being the amount
10 of colour difference between the test and reference colours.

6. A method according to claim 5, wherein the colour difference is defined
by a fuzzy variable.

- 15 7. A method according to claim 6, wherein the fuzzy variable is represented
by:

$$d_i = d(P_i^S, P_i^T) = \frac{1}{k} \times \sum_{x=1}^k d^x(P_i^S, P_i^T);$$

where,

d_i is the colour difference between i th pair of corresponding reference
20 colour P_i^S and test colour P_i^T ;

k is the number of colour components; and

d^x is the mean colour density difference between the i th pair of
corresponding reference colour P_i^S and test colour P_i^T for x colour
component.

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8. A method according to claim 7, further comprising the step of calculating amount of noise present in each colour pair.

5 9. A method according to any one of the preceding claims, wherein the colour difference calculation is based on CMYK colour model.

10. A method according to any one of claims 1 to 8, wherein the colour difference calculation is based on RGB colour model.

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11. A method according to any one of claims 1 to 8, wherein the colour difference calculation is based on CIEL*A*B*.

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12. A method according to any one of the preceding claims, wherein the adjusting step is based on fuzzy inference.

13. A method according to claim 12, wherein the adjustment is automatic.

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14. A method according to any one of the preceding claims, further comprising the step of verifying the print engine's output prior to the adjustment step (iv).

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15. A method according to claim 14, wherein the verification step provides a user interface to manually adjust the colour difference between corresponding pairs of test and reference colours.

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16. A method of calibrating a print engine, comprising the steps of:

(i) capturing an image including a first plurality of reference colours and a second plurality of test colours printed by the print engine, each test

colour corresponding to a reference colour;

(ii) digitising the reference and test colours;

(iii) using fuzzy functions to calculate a difference in colour between corresponding pairs of digitised reference and test colours;

(iv) defining the difference as a fuzzy value; and

(v) adjusting the print engine based on the fuzzy value to reduce the colour difference between each colour pair.

17. A method according to claim 16, wherein the reference colours are provided on a calibration chart and the test colours are provided on a

separate test sheet prior to the image capture of step (i).

18. A method according to claim 16 or 17, wherein each reference or test colour is formed from a combination of one or more colour components.

19. A method according to claim 18, wherein step (ii) further comprises the steps of:

obtaining pixel information from the digital image; and

computing density of each colour component at each pixel for each test and/or reference colour.

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20. A method according to claim 19, further comprising the steps of:
 averaging the computed densities to obtain a mean density of each
 colour component for each test and reference colour; and
 calculating the colour difference between corresponding pairs of test and
 reference colours based on respective mean densities.

21. A method according to claim 20, wherein the colour difference is
 represented by a fuzzy variable , d_i , defined as:

$$d_i = d(P_i^s, P_i^T) = \frac{1}{k} \times \sum_{x=1}^k d^x(P_i^s, P_i^T);$$

where,

k is the number of colour components; and

d^x is the mean colour density difference between the ith pair of
 corresponding reference colour P_i^s and test colour P_i^T for x colour
 component.

22. A method according to claim 21, further comprising the step of deriving
 colour channels containing one colour component based on d^x .

23. A method according to claim 22, further comprising the step of
 calculating a colour difference between colour channels.

24. A method according to claim 23, wherein the colour channel difference is
 defined as a fuzzy variable, fd_i , where

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$$fd_i = fd(P_i^S, P_i^T) = \frac{1}{m} \times \sum_{x \text{ is a filtered channel}} fd^x(P_i^S, P_i^T)$$

where m is the number of filtered colour channels; and

fd^x is the mean colour density difference between the ith pair of corresponding reference colour P_i^S and test colour P_i^T for x colour component which is a filtered colour channel.

25. A method according to claim 24, further comprising the step of calculating noise ε_i which is defined by:

$$\varepsilon_i = \varepsilon(P_i^S, P_i^T) = d(P_i^S, P_i^T) - fd(P_i^S, P_i^T) \quad .$$

26. A method according to any one of claims 16 to 25, further comprising the step of verifying the print engine's output prior to the adjustment step (v).

27. A method according to any one of claims 16 to 26, further comprising the step of: detecting the position of each digitised reference and test colour prior to the calculation step (iii).

28. A method according to claim 16 to 27, further comprising the step of detecting reference marks in the captured image prior to the digitising step (ii).

29. A method according to claim 28, further comprising the step of comparing the position of the reference marks with default position values of the reference marks;

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calculating the difference; and

locating the positions of each reference and test colour in the captured image to perform the digitisation step.

- 5 30. A method of deriving an adjustment value for a print engine, the method comprising the steps of:
- (i) capturing an image including a first plurality of reference colours and a second plurality of test colours printed by the print engine, each test colour corresponding to a reference colour;
- 10 (ii) digitising the reference and test colours;
- (iii) calculating a difference in colour between corresponding pairs of digitised reference and test colours; and
- (iv) providing the calculated colour difference for verification.
- 15 31. A method according to claim 30, wherein step (iv) further comprises the step of displaying the colour difference.
32. A method according to claim 31, wherein the colour difference is displayed in graphical form.
- 20 33. A method according to any one of claims 30 to 32, further comprising the step of adjusting the print engine based on the calculated difference to reduce the colour difference between each colour pair.

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34. A method according to claim 33, wherein the adjustment step is performed before step (iv).

35. A method according to claim 33, wherein the adjustment step is performed after step (iv).

36. A method according to claim 34, further comprising the steps of:
printing a test sheet including the plurality of test colours from the adjusted print engine; and
visually comparing the test colours against a plurality of reference colours provided on a calibration chart.

37. Apparatus for calibrating a print engine based on a calibration chart having openings formed therein and a first plurality of reference colours, the apparatus comprising:

i) a print engine arranged to print a test sheet having a second plurality of test colours, each test colour corresponding to a reference colour and the positions of the second plurality of test colours corresponding to the openings of the calibration chart when the chart is arranged on the test sheet;

ii) means for digitising the reference and test colours;

iii) processing means for calculating a colour difference between corresponding pairs of digitised reference and test colours; and

iv) control means for adjusting the print engine in accordance with the difference to reduce the colour difference between each colour pair.

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38. Apparatus for calibrating a print engine comprising:

(i) an image capturing device arranged to capture an image including a first plurality of reference colours and a second plurality of test colours printed by the print engine, each test colour corresponding to a reference colour;

ii) means for digitising the reference and test colours;

(iii) processing means for calculating a difference in colour between corresponding pairs of digitised reference and test colours using fuzzy functions;

(iv) processing means for defining the difference as a fuzzy value; and

(v) control means for adjusting the print engine based on the fuzzy value to reduce the colour difference between each colour pair.

39. Apparatus for deriving an adjustment value for a print engine comprising:

(i) an image capturing device arranged to capture an image including a first plurality of reference colours and a second plurality of test colours printed by the print engine, each test colour corresponding to a reference colour;

ii) means for digitising the reference and test colours;

(iii) processing means for calculating a difference in colour between corresponding pairs of digitised reference and test colours; and

(iv) verification means for checking the calculated colour difference.

40. Apparatus according to claim 39, further comprising a display.

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41. Apparatus according to claim 39 or 40, further comprising control means for adjusting the print engine based on the calculated difference to reduce the colour difference between each colour pair.

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42. Calibration apparatus according to claim 41, further comprising input devices to control the control means.